CLAIMS:

1. A reflective liquid crystal display element comprising:

a pair of substrates;

a polymer–dispersed liquid crystal layer, in which liquid crystal drops are dispersed in a polymer, the polymer–dispersed liquid crystal layer being arranged between the pair of substrates; and

a reflective layer formed on one substrate of the pair of substrates;

wherein display is carried out by applying an electric field across the polymer–dispersed liquid crystal layer to change a light–scattering state of the polymer–dispersed liquid crystal layer; and

wherein a scattering gain of the polymer–dispersed liquid crystal layer is set in accordance with a thickness of the polymer–dispersed liquid crystal layer.

2. The reflective liquid crystal display element according to Claim 1, wherein the scattering gain is the scattering gain for transmitted light when the polymer–dispersed liquid crystal layer is formed in a transmissive panel.

3. The reflective liquid crystal display element according to Claim 1, wherein the thickness d of the polymer–dispersed liquid crystal layer is at least 3μm and at most 8μm.

4. The reflective liquid crystal display element according to Claim 1,

wherein a particle diameter of the liquid crystal drops in the polymer–dispersed liquid crystal layer is set in accordance with the thickness of the polymer–dispersed liquid crystal layer.

5. A reflective liquid crystal display element comprising:

a pair of substrates;

a polymer–dispersed liquid crystal layer, in which liquid crystal drops are dispersed in a polymer, the polymer–dispersed liquid crystal layer being arranged between the pair of substrates; and

a reflective layer formed on one substrate of the pair of substrates;

wherein display is carried out by applying an electric field across the polymer–dispersed liquid crystal layer to change a light–scattering state of the polymer–dispersed liquid crystal layer; and

wherein a scattering gain of the polymer–dispersed liquid crystal layer is set in accordance with a level of refractive index anisotropy of the liquid crystal included in the polymer–dispersed liquid crystal layer.

6. The reflective liquid crystal display element according to Claim 5 wherein the particle diameter of the liquid crystal drops in the polymer–dispersed liquid crystal layer is set in accordance with the level of refractive index anisotropy of the liquid crystal.

7. A reflective liquid crystal display element comprising:

a pair of substrates;

a polymer–dispersed liquid crystal layer, in which liquid crystal drops are dispersed in a polymer, the polymer–dispersed liquid crystal layer being arranged between the pair of substrates; and

a reflective layer formed on one substrate of the pair of substrates;

wherein display is carried out by applying an electric field across the polymer–dispersed liquid crystal layer to change a light–scattering state of the polymer–dispersed liquid crystal layer; and

wherein the scattering gain of the polymer–dispersed liquid crystal layer is set in accordance with a thickness of the polymer–dispersed liquid crystal layer and a level of refractive index anisotropy of the liquid crystal included in the polymer–dispersed liquid crystal layer.

8. A reflective liquid crystal display element comprising:

a pair of substrates;

a polymer–dispersed liquid crystal layer, in which liquid crystal drops are dispersed in a polymer, the polymer–dispersed liquid crystal layer being arranged between the pair of substrates; and

a reflective layer formed on one substrate of the pair of substrates;

wherein display is carried out by applying an electric field across the polymer–dispersed liquid crystal layer to change a light–scattering state of the polymer–dispersed liquid crystal layer; and

satisfying the relation $50\exp(-0.4d) < SG < 360\exp(-0.47d)$, wherein d is a thickness of the polymer–dispersed liquid crystal layer and SG is a scattering gain of the polymer–dispersed liquid crystal layer.

9. The reflective liquid crystal display element according to Claim 8, wherein the scattering gain is the scattering gain for transmitted light when the polymer–dispersed liquid crystal layer is formed in a transmissive panel.

10. The reflective liquid crystal display element according to Claim 8, wherein the thickness d of the polymer–dispersed liquid crystal layer is at least 3μm and at most 8μm.

11. The reflective liquid crystal display element according to Claim 8, wherein the scattering gain of the liquid crystal layer is at least 10 and at most 200.

12. The reflective liquid crystal display element according to Claim 11, wherein the scattering gain of the liquid crystal layer is at least 10 and at most 200 within a usage temperature range of the liquid crystal display device.

13. A reflective liquid crystal display element comprising:

a pair of substrates;

a polymer–dispersed liquid crystal layer, in which liquid crystal drops are dispersed in a polymer, the polymer–dispersed liquid crystal layer being arranged between the pair of substrates; and

a reflective layer formed on one substrate of the pair of substrates;

wherein display is carried out by applying an electric field across the polymer–dispersed liquid crystal layer to change a light–scattering state of the polymer–dispersed liquid crystal layer; and

satisfying the relation $50\exp(-1.6\Delta n\cdot d) < SG < 360\exp(-1.88\Delta n\cdot d)$, wherein d(μm) is a thickness of the polymer–dispersed liquid crystal layer and SG is a scattering gain of the polymer–dispersed liquid crystal layer.

14. The reflective liquid crystal display element according to Claim 13, wherein the scattering gain is the scattering gain for transmitted light when the polymer–dispersed liquid crystal layer is formed in a transmissive panel.

15. The reflective liquid crystal display element according to Claim 13, wherein the thickness d of the polymer–dispersed liquid crystal layer is at least 3μm and at most 8μm.

16. The reflective liquid crystal display element according to Claim 13, wherein the scattering gain of the liquid crystal layer is at least 10 and at most 200.

17. The reflective liquid crystal display element according to Claim 16, wherein the scattering gain of the liquid crystal layer is at least 10 and at most 200 within a usage temperature range of the liquid crystal display device.

18. A reflective liquid crystal display element comprising:

a pair of substrates;

a polymer–dispersed liquid crystal layer, in which liquid crystal drops are dispersed in a polymer, the polymer–dispersed liquid crystal layer being arranged between the pair of substrates;

a reflective layer formed on one substrate of the pair of substrates;

wherein display is carried out by applying an electric field across the polymer–dispersed liquid crystal layer to change a light–scattering state of the polymer–dispersed liquid crystal layer; and

wherein the product of a birefringence of the liquid crystal and a thickness of the polymer–dispersed liquid crystal layer is at least 0.6μm and at most 2.2μm.

19. The reflective liquid crystal display element according to Claim 18, wherein a particle diameter of the liquid crystal drops is at least 0.7μm and at most 2μm.

20. The reflective liquid crystal display element according to Claim 18, wherein the birefringence of the liquid crystal is at least 0.15μm and at most 0.27μm.

21. The reflective liquid crystal display element according to Claim 18, wherein the thickness of the polymer–dispersed liquid crystal layer is at least 3μm and at most 8μm.

22. A reflective liquid crystal display element comprising:

a pair of substrates;

a polymer–dispersed liquid crystal layer, in which liquid crystal drops are dispersed in a polymer, the polymer–dispersed liquid crystal layer being arranged between the pair of substrates;

a reflective layer formed on one substrate of the pair of substrates;

wherein display is carried out by applying an electric field across the polymer–dispersed liquid crystal layer to change a light–scattering state of the polymer–dispersed liquid crystal layer;

wherein the liquid crystal drops near the border of the substrates are formed substantially as semi–spheres whose great circles contact the substrates; and

wherein directors of the liquid crystal inside the semi–spherical liquid crystal drops are arranged substantially uniformly in parallel to the substrates.

23. The reflective liquid crystal display element according to Claim 22, wherein the directors of the liquid crystal inside the semi–spherical liquid crystal drops at the border of one of the pair of substrates and the directors of the liquid crystal inside the liquid crystal drops at the border of the other of the pair of substrates are substantially parallel.

24. The reflective liquid crystal display element according to Claim 22,

wherein the thickness of the polymer-dispersed liquid crystal layer is at least 3μm and at most 8μm.

25. A reflective liquid crystal display element comprising:

a pair of substrates;

a polymer-dispersed liquid crystal layer, in which liquid crystal drops are dispersed in a polymer, the polymer-dispersed liquid crystal layer being arranged between the pair of substrates;

a reflective layer formed on one substrate of the pair of substrates; and

an RGB color filter formed on one of the substrates;

wherein display is carried out by applying an electric field across the polymer-dispersed liquid crystal layer to change a light-scattering state of the polymer-dispersed liquid crystal layer;

wherein, when d(μm) is a thickness of polymer-dispersed liquid crystal layer, and, among the scattering gains for green light in the polymer-dispersed liquid crystal layer, SGr is a scattering gain of a red pixel region, SGg is a scattering gain of a green pixel region, and SGb is a scattering gain of a blue pixel region, then

$50\exp(-0.4d) < SGg < 360\exp(-0.47d)$ is satisfied in the green pixel region;

$50\exp(-0.4d) < SGb < 360\exp(-0.47d)$ is satisfied in the blue pixel region; and

$40\exp(-0.3d) < SGr < 650\exp(-0.4d)$ is satisfied in the red pixel

region.

26. The reflective liquid crystal display element according to Claim 25, satisfying dR > dG > dB, wherein dR is a layer thickness of the red pixel region, dG is a layer thickness of the green pixel region, and dB is a layer thickness of the blue pixel region.

27. The reflective liquid crystal display element according to Claim 25, satisfying rR > rG > rB, wherein rR is a particle diameter of the crystal drops in the red pixel region, rG is a particle diameter of the crystal drops in the green pixel region, and rB is a particle diameter of the crystal drops in the blue pixel region.

28. The reflective liquid crystal display element according to Claim 25, wherein the color filter is formed on the reflective layer, and the polymer–dispersed liquid crystal layer is formed on the color filter.

29. The reflective liquid crystal display element according to Claim 8, wherein, when viewed from a predetermined viewing direction, there is a luminance peak in the luminance – voltage characteristics as the liquid crystal layer is changed from the scattering state to the transmitting state; and

wherein a range between a voltage at the luminance peak in the voltage – luminance characteristics and a voltage at which the luminance

becomes approximately zero is taken as a driving voltage range.

30. The reflective liquid crystal display element according to Claim 13, wherein, when viewed from a predetermined viewing direction, there is a luminance peak in the luminance – voltage characteristics as the liquid crystal layer is changed from the scattering state to the transmitting state; and

wherein a range between a voltage at the luminance peak in the voltage – luminance characteristics and a voltage at which the luminance becomes approximately zero is taken as a driving voltage range.

31. The reflective liquid crystal display element according to Claim 29, wherein said viewing direction is set to a direction that is different from an emission direction, in which light is emitted frontwards from the liquid crystal layer when the liquid crystal layer is in the transmitting state.

32. The reflective liquid crystal display element according to Claim 30, wherein said viewing direction is set to a direction that is different from an emission direction, in which light is emitted frontwards from the liquid crystal layer when the liquid crystal layer is in the transmitting state.

SUS A27 33. A scattering display element comprising:

a scattering/transmission means switching between a scattering state, in which incident light is scattered, and a transmitting state, in which

incident light is transmitted;

a reflection means for reflecting light that is incident from a display side of the scattering/transmission means and scattered on a rear side, as well as light that is transmitted by the scattering/transmission means; and

an anisotropic scattering means, which, when the scattering/transmission means is in the transmitting state, scatters and emits light, that is incident on the scattering display element, into a range of directions with anisotropy.

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34. The scattering display element according to Claim 33, wherein the anisotropic scattering means scatters and emits light, that is incident on the scattering display element, into a range of directions that is broader in a horizontal direction of a display screen than in a vertical direction of the display screen.

35. The scattering display element according to Claim 33, wherein the reflection means is part of the anisotropic scattering means.

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36. The scattering display element according to Claim 35, wherein the anisotropic scattering means is made by forming protrusions whose curvature in a horizontal direction of the display screen is larger than the curvature in a vertical direction of the display screen on a surface of the reflection means.

37. The scattering display element according to Claim 33, wherein the anisotropic scattering means includes an anisotropic transmission means, which scatters and transmits incident light into a range of directions with anisotropy.

pu S A4 38. The scattering display element according to Claim 37, wherein protrusions whose curvature in a horizontal direction of the display screen is larger than the curvature in a vertical direction of the display screen are formed on a surface of the anisotropic transmission means.

39. The scattering display element according to Claim 38, wherein the anisotropic transmission means is a lens sheet film.

Su S A5 40. The scattering display element according to Claim 33, wherein the anisotropic scattering means is an anisotropic diffraction means.

pu S A6 41. A scattering display element comprising:

a scattering/transmission means for switching between a scattering state, in which incident light is scattered, and a transmitting state, in which incident light is transmitted;

a reflection means for reflecting light that is incident from a display side of the scattering/transmission means and scattered on a rear side, as well as light that is transmitted by the scattering/transmission means; and

an emission angle modification means, which, when the

scattering/transmission means is in the transmitting state, emits light, that is incident on the scattering display element, into a direction such that the incidence angle is different from the emission angle.

42. The scattering display element according to Claim 41, wherein the emission angle modification means is configured such that the emission angle is larger than the incidence angle.

43. The scattering display element according to Claim 42, wherein the reflection means is part of the emission angle modification means.

44. The scattering display element according to Claim 43, wherein the emission angle modification means is made by providing the reflection means with regions, in which a normal on a reflection surface is tilted downward with respect to the display screen against a normal on a display surface.

45. The scattering display element according to Claim 44, wherein a cross–section of the reflection means in vertical direction of the display screen is provided with a shape having sawtooth–shaped portions.

46. The scattering display element according to Claim 45, wherein an inclination angle, with respect to the display surface, of an inclined surface in the cross–sectional shape having sawtooth–shaped portions is at least 5°

and at most 30°.

47. The scattering display element according to Claim 46, wherein an inclination angle with respect to the display surface of an inclined surface in the cross-section having sawtooth-shaped portions is at least 5° and at most 15°.

48. The scattering display element according to Claim 45, provided with a plurality of the cross-sectional shapes having sawtooth-shaped portions, wherein a pitch between the cross-sectional shapes is set to at least 5μm and at most 100μm.

49. The scattering display element according to Claim 45, provided with a plurality of the cross-sectional shapes having sawtooth-shaped portions, wherein pitches between the cross-sectional shapes are set to a plurality of varying sizes.

50. The scattering display element according to Claim 49, wherein the pitches of varying sizes are arranged at random.

51. The scattering display element according to Claim 45, provided with a plurality of the cross-sectional shapes having sawtooth-shaped portions, wherein pitches between the cross-sectional shapes are set to at least 5μm and at most 100μm, and the difference between the largest pitch and the

smallest pitch is set to be not larger than 30μm.

52. The scattering display element according to Claim 43,

wherein, in a cross–section of the reflection means in a vertical direction of the display screen, a normal on a reflection surface is tilted downward with respect to the display screen against a normal on a display surface; and

wherein the reflection means is provided with a plurality of protrusions whose cross–sectional shape protrudes in a horizontal direction of the display screen are formed.

53. The scattering display element according to Claim 52, wherein the protrusions are arranged at random positions.

pos A7 54. The scattering display element according to Claim 42, wherein the emission angle modification means includes a refraction/transmission means for refracting and transmitting incident light.

55. The scattering display element according to Claim 54, wherein the refraction/transmission means is provided with a region that is thicker at a higher position of the display screen than at a lower position of the display screen.

56. The scattering display element according to Claim 55, wherein a

cross–section of the refraction/transmission means in vertical direction of the display screen is provided with a shape of a plurality of half convex lenses or prisms.

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57. The scattering display element according to Claim 41, wherein the emission angle modification means is configured such that light that is incident on the scattering display element is emitted substantially in a direction back toward the direction of incidence.

58. The scattering display element according to Claim 57, wherein the emission angle modification means is configured by providing the reflection means with retroreflector shape.

59. The scattering display element according to Claim 43,

wherein the reflection means, which is part of the emission angle modification means, is a reflective film substrate; and

wherein the scattering/transmission means is disposed between the reflective film substrate and an array substrate on which transparent pixel electrodes are formed and which is provided at a predetermined interval to the reflective film substrate.

60. The scattering display element according to Claim 59, wherein a cross–section of the reflection means in vertical direction of the display screen is provided with a shape having sawtooth–shaped portions.

61. The scattering display element according to Claim 60, wherein the inclination angle, with respect to a display surface, of an inclined surface in the cross-sectional shape having sawtooth-shaped portions is at least 5° and at most 30°.

62. The scattering display element according to Claim 59, wherein a color filter is provided on either the reflective film substrate or the array substrate.

pus A41 63. A scattering display element comprising:

a scattering/transmission means for switching between a scattering state, in which incident light is scattered, and a transmitting state, in which incident light is transmitted;

a reflection means for reflecting light that is incident from a display side of the scattering/transmission means and scattered on a rear side, as well as light that is transmitted by the scattering/transmission means; and

a means for confining within the scattering display element at least a portion of the light that is incident on the scattering display element when the scattering/transmission means is in the transmitting state.

64. A scattering display element comprising:

a scattering/transmission means for switching between a scattering state, in which incident light is scattered, and a transmitting state, in which incident light is transmitted

incident light is transmitted;

a reflection means for reflecting light that is incident from a display side of the scattering/transmission means and scattered on a rear side, as well as light that is transmitted by the scattering/transmission means; and

an attenuation means for attenuating an amount of light reflected by the reflection means.

65. The scattering display element according to Claim 64, wherein the reflection means reflects and transmits light or reflects and absorbs light, and is part of the attenuation means.

66. The scattering display element according to Claim 65, wherein an optical reflectivity of the reflection means is not higher than 90%.

67. The scattering display element according to Claim 65, wherein the reflection means includes chromium.

68. The scattering display element according to Claim 64, wherein the attenuation means includes a polarization means, which blocks light of a predetermined polarization.

69. The scattering display element according to Claim 68, wherein the polarization means is arranged such that it blocks light that is polarized in a horizontal direction of the display screen.

70. The scattering display element according to Claim 68, wherein the polarization means is disposed between the scattering/transmission means and the reflection means.

71. The scattering display element according to Claim 64, wherein the attenuation means is a dispersive film of at least 70% and at most 95% transmissivity, disposed on a display surface side of the scattering/transmission means.

DUSA 607 72. A method for manufacturing a display element comprising a reflection means for reflecting incident light, wherein a step of forming said reflection means comprises the steps of:

forming a resin layer including micro-particles on a substrate; and

forming a reflective layer on the resin layer.

DUSA 607 73. A method for manufacturing a display element comprising a reflection means for reflecting incident light, wherein a step of forming said reflection means comprises the steps of:

forming a resin layer of a predetermined pattern on a substrate;

heating and softening the resin layer, such that its surface is provided with a predetermined curvature; and

forming a reflective layer on the resin layer.

AuSA107 74. A method for manufacturing a display element comprising a reflection means for reflecting incident light, wherein a step of forming said reflection means comprises the steps of:

forming a resin layer on a substrate;

providing a surface of the resin layer with a predetermined shape by press-forming; and

forming a reflective layer on the resin layer.

75. A method for manufacturing a display element comprising a reflection means for reflecting incident light, wherein a step of forming said reflection means comprises the steps of:

forming a resin layer on a substrate;

forming a protective film of a predetermined pattern on the resin layer;

shaping the resin film by dry etching or sandblasting from a direction that is oblique with respect to the normal on the substrate;

forming a reflective layer on the resin layer after eliminating the protective film.

76. A method for manufacturing a display element comprising a reflection means for reflecting incident light, wherein a step of forming said reflection means comprises the steps of:

forming a first resin layer on a portion of a substrate;

forming a second resin layer on a portion of a region including at

least a portion of the first resin layer, so as to form a cross–section having a non–symmetric shape; and

forming a reflective layer on a region including the non–symmetric shape.

77. The method for manufacturing a display element according to Claim 76, wherein the second resin layer is formed after forming the first resin layer with a shape having oblique portions.

78. The method for manufacturing a display element according to Claim 77, wherein the second resin layer is formed with a shape having oblique portions.

79. The method for manufacturing a display element according to Claim 77, wherein the first resin layer is provided with a shape having oblique portions by annealing.

80. The method for manufacturing a display element according to Claim 78, wherein the second resin layer is provided with a shape having oblique portions by annealing.

81. The method for manufacturing a display element according to Claim 77, wherein the non–symmetric shape includes at least a sawtooth–shaped portion.

82. The method for manufacturing a display element according to Claim 78, wherein the non-symmetric shape includes at least a sawtooth-shaped portion.

83. The method for manufacturing a display element according to Claim 79, wherein the non-symmetric shape includes at least a sawtooth-shaped portion.

84. The method for manufacturing a display element according to Claim 80, wherein the non-symmetric shape includes at least a sawtooth-shaped portion.

85. The method for manufacturing a display element according to Claim 76,

wherein the first resin layer and the second resin layer are made of photosensitive resin; and

wherein the steps of forming the first resin layer and the second resin layer on a portion of the substrate include forming a resin layer on an entire substrate, followed by exposing the resin layer through a first light-blocking mask and a second light-blocking mask having predetermined patterns, and developing, so as to form a shape with non-symmetric cross-section.

86. The method for manufacturing a display element according to Claim

85, wherein an exposure portion of the first light–blocking mask is shifted with respect to an exposure portion of the second light–blocking mask, so that said exposing forms a second resin layer on a portion of a region including at least a portion of the first resin layer.

87. The method for manufacturing a display element according to Claim 85, wherein the photosensitive resin is a positive photosensitive resin, and light–blocking portions of the second light–blocking mask are larger than light–blocking portions of the first light–blocking mask.

88. The method for manufacturing a display element according to Claim 87, wherein a width of light–blocking portions of the second light–blocking mask is larger than a width of the light–blocking portions of the first light–blocking mask.

89. The method for manufacturing a display element according to Claim 85, wherein the photosensitive resin is a negative photosensitive resin, and light–blocking portions of the second light–blocking mask are smaller than light–blocking portions of the first light–blocking mask.

90. The method for manufacturing a display element according to Claim 89, wherein a width of light–blocking portions of the second light–blocking mask is smaller than a width of the light–blocking portions of the first light–blocking mask.

91. The method for manufacturing a display element according to Claim 85, wherein the exposure with the first light-blocking mask and the exposure with the second light-blocking mask is performed by irradiating light from a direction of a normal on the substrate.

92. The method for manufacturing a display element according to Claim 85, wherein at least one of the exposure with the first light-blocking mask and the exposure with the second light-blocking mask is performed by irradiating light from a direction of a normal on the substrate.

93. A method for manufacturing a display element comprising a reflection means for reflecting incident light, wherein a step of forming said reflection means comprises the steps of:

partially forming a first resin layer on a substrate;

forming a shape having a non-symmetric cross section by partially forming a second resin layer on a portion of a region including at least a portion of the first resin layer and then eliminating at least a portion of the first resin layer or the second resin layer; and

forming a reflective layer on a region including this non-symmetric shape.

94. The method for manufacturing a display element according to Claim

93, wherein the step of eliminating the resin layer is performed by dry etching with a mask of a predetermined pattern.

95. The method for manufacturing a display element according to Claim 93, wherein the non-symmetric shape includes at least a sawtooth-shaped portion.

96. The method for manufacturing a display element according to Claim 72, wherein the reflective layer is an electrode for driving the display element.

97. A scattering-mode liquid crystal display device performing display by switching a liquid crystal layer between a scattering state and a transmitting state,

having luminance – voltage characteristics that exhibit a peak in the luminance level as the liquid crystal layer is changed from the scattering state to the transmitting state, when viewing from a predetermined viewing direction; and

wherein a driving voltage range is set to a range between a voltage at the luminance peak in the luminance – voltage characteristics and a voltage at which the luminance level is substantially zero.

98. A scattering-mode liquid crystal display device performing display by switching a liquid crystal layer between a scattering state and a

transmitting state,

wherein the scattering mode is a normally-white mode, in which the liquid crystal layer is in the scattering state when no voltage is applied, and the display is bright;

having luminance – voltage characteristics in which, as the applied voltage is increased from 0V, the luminance level increases once from an initial level until it reaches a peak, and then decreases to substantially zero, when viewing from a predetermined viewing direction;

wherein a driving voltage range is set to a range between a voltage at which the luminance level in the luminance – voltage characteristics peaks and a voltage at which the luminance level is substantially zero.

99. A scattering-mode liquid crystal display device performing display by switching a liquid crystal layer between a scattering state and a transmitting state,

wherein the scattering mode is a normally-black mode, in which the liquid crystal layer is in the transmitting state when no voltage is applied, and the display is dark;

having luminance – voltage characteristics in which, as the applied voltage is increased from 0V until reaching a threshold voltage, the luminance level is substantially zero, and as the applied voltage increases beyond the threshold voltage, the luminance increases until it reaches a peak, and then decreases, when viewing from a predetermined viewing direction;

wherein a driving voltage range is set to a range between the threshold voltage at which the luminance level in the luminance – voltage characteristics starts to change and a voltage at which the luminance level peaks.

100. The liquid crystal display device according to Claim 98, wherein there is a plurality of peaks of the luminance level in the luminance – voltage characteristics, and wherein the driving voltage range is set to a range between the highest voltage of the voltages at those peaks and a voltage at which the luminance level is substantially zero.

101. The liquid crystal display device according to Claim 99, wherein there is a plurality of peaks of the luminance level in the luminance – voltage characteristics, and wherein the driving voltage range is set to a range between the threshold voltage at which the luminance level starts to change from zero and the lowest voltage of the voltages at those peaks.

102. The liquid crystal display device according to Claim 97, wherein the viewing direction is set to a direction that is different from an emission direction in which light is emitted frontward from the liquid crystal layer when the liquid crystal layer is in the transmitting state.

103. The liquid crystal display device according to Claim 98, wherein the viewing direction is set to a direction that is different from an emission

direction in which light is emitted frontward from the liquid crystal layer when the liquid crystal layer is in the transmitting state.

104. The liquid crystal display device according to Claim 99, wherein the viewing direction is set to a direction that is different from an emission direction in which light is emitted frontward from the liquid crystal layer when the liquid crystal layer is in the transmitting state.

105. The liquid crystal display device according to Claim 98, which is driven by bias driving.

106. The liquid crystal display device according to Claim 99, which is driven by ~~bias driving~~.

107. The liquid crystal display device according to Claim 105, wherein the bias voltage for the bias driving can be adjusted.

108. The liquid crystal display device according to Claim 106, wherein the bias voltage for the bias driving can be adjusted.

109. The liquid crystal display device according to Claim 97, further comprising a driving voltage adjustment means for adjusting the driving voltage in accordance with a change in the luminance – voltage characteristics such that the driving voltage is in said driving voltage range.

110. The liquid crystal display device according to Claim 98, further comprising a driving voltage adjustment means for adjusting the driving voltage in accordance with a change in the luminance – voltage characteristics such that the driving voltage is in said driving voltage range.

111. The liquid crystal display device according to Claim 99, further comprising a driving voltage adjustment means for adjusting the driving voltage in accordance with a change in the luminance – voltage characteristics such that the driving voltage is in said driving voltage range.

112. The liquid crystal display device according to Claim 109, further comprising a detection means for detecting a voltage substantially corresponding to a peak value in the luminance level, and wherein the driving voltage adjustment means adjusts the driving voltage in accordance with a result of this detection.

113. The liquid crystal display device according to Claim 110, further comprising a detection means for detecting a voltage substantially corresponding to a peak value in the luminance level, and wherein the driving voltage adjustment means adjusts the driving voltage in accordance with a result of this detection.

114. The liquid crystal display device according to Claim 111, further

comprising a detection means for detecting a voltage substantially corresponding to a peak value in the luminance level, and wherein the driving voltage adjustment means adjusts the driving voltage in accordance with a result of this detection.

115. The liquid crystal display device according to Claim 109, further comprising a detection means for detecting a temperature at which the liquid crystal display device is used, and wherein the driving voltage adjustment means adjusts the driving voltage in accordance with a result of this detection.

116. The liquid crystal display device according to Claim 110, further comprising a detection means for detecting a temperature at which the liquid crystal display device is used, and wherein the driving voltage adjustment means adjusts the driving voltage in accordance with a result of this detection.

117. The liquid crystal display device according to Claim 111, further comprising a detection means for detecting a temperature at which the liquid crystal display device is used, and wherein the driving voltage adjustment means adjusts the driving voltage in accordance with a result of this detection.

118. The liquid crystal display device according to Claim 97, wherein a

reflector for reflecting light that is incident from a front side of the liquid crystal layer and emitting it to the front side is provided on a rear side of the liquid crystal layer.

119. The liquid crystal display device according to Claim 98, wherein a reflector for reflecting light that is incident from a front side of the liquid crystal layer and emitting it to the front side is provided on a rear side of the liquid crystal layer.

120. The liquid crystal display device according to Claim 99, wherein a reflector for reflecting light that is incident from a front side of the liquid crystal layer and emitting it to the front side is provided on a rear side of the liquid crystal layer.

121. The liquid crystal display device according to Claim 97, further comprising a light source on a rear side of the liquid crystal layer, wherein oblique light from the light source is transmitted through the liquid crystal layer and emitted to a front side.

122. The liquid crystal display device according to Claim 98, further comprising a light source on a rear side of the liquid crystal layer, wherein oblique light from the light source is transmitted through the liquid crystal layer and emitted to a front side.

123. The liquid crystal display device according to Claim 99, further comprising a light source on a rear side of the liquid crystal layer, wherein oblique light from the light source is transmitted through the liquid crystal layer and emitted to a front side.

124. The liquid crystal display device according to Claim 97, wherein display is performed by active matrix driving.

125. The liquid crystal display device according to Claim 98, wherein display is performed by active matrix driving.

126. The liquid crystal display device according to Claim 99, wherein display is performed by active matrix driving.

127. The liquid crystal display device according to Claim 97, wherein display is performed by simple matrix driving.

128. The liquid crystal display device according to Claim 98, wherein display is performed by simple matrix driving.

129. The liquid crystal display device according to Claim 99, wherein display is performed by simple matrix driving.

130. A method for driving a scattering–mode liquid crystal display device,

in which display is performed by switching a liquid crystal layer between a scattering state and a transmitting state,

wherein the display device is driven by bias driving.

131. The method for driving the liquid crystal display device according to Claim 130, wherein the display device is driven by active driving with an active element array.

132. The method for driving the liquid crystal display device according to Claim 130, wherein the bias driving is inversion driving.

133. The method for driving the liquid crystal display device according to Claim 130, wherein the bias driving is floating gate driving.

134. The method for driving the liquid crystal display device according to Claim 130, wherein the bias driving is capacitive coupling driving.

135. The method for driving the liquid crystal display device according to Claim 130, wherein said predetermined voltage generated by said bias driving means is variable.

136. A scattering-mode liquid crystal display device performing display by switching a liquid crystal layer between a scattering state and a transmitting state,

having luminance – voltage characteristics in which, as the liquid crystal layer changes from the scattering state to the transmitting state, there is a luminance level that is higher than the luminance level when the applied voltage is 0V, when viewing from a predetermined viewing direction.

137. The liquid crystal display device according to Claim 136, wherein the driving voltage range is set to a range between a voltage at which a luminance level in the luminance – voltage characteristics is higher than the luminance at an applied voltage of 0V and a voltage at which the luminance level has monotonously decreased from said higher luminance level to about zero.

138. The liquid crystal display device according to Claim 136, wherein a luminance level that is higher than the luminance level at an applied voltage of 0V, which changes depending on the usage temperature of the liquid crystal display device, is configured to be highest within a usage temperature range.

139. The liquid crystal display device according to Claim 136, wherein a luminance level that is higher than the luminance level at an applied voltage of 0V, which changes depending on the usage temperature of the liquid crystal display device, is configured to be highest approximately at room temperature.

140. The liquid crystal display device according to Claim 136, wherein a liquid phase – isotropic phase phase shift temperature in a liquid crystal material of the liquid crystal layer is at least 20°C higher than an upper limit of the usage temperature range of the liquid crystal device.

141. The liquid crystal display device according to Claim 136, wherein a liquid phase – isotropic phase phase shift temperature in a liquid crystal material of the liquid crystal layer is at least 80°C.

142. The liquid crystal display device according to Claim 97, wherein a luminance level peak, which changes depending on the usage temperature of the liquid crystal display device, is configured to be highest within a usage temperature range.

143. The liquid crystal display device according to Claim 97, wherein a luminance level peak, which changes depending on the usage temperature of the liquid crystal display device, is configured to be highest approximately at room temperature.

144. The liquid crystal display device according to Claim 97, wherein a liquid phase – isotropic phase phase shift temperature in a liquid crystal material of the liquid crystal layer is at least 20°C higher than an upper limit of the usage temperature range of the liquid crystal device.

145. The liquid crystal display device according to Claim 97, wherein a liquid phase – isotropic phase phase shift temperature in a liquid crystal material of the liquid crystal layer is at least 80°C.

146. The liquid crystal display device according to Claim 97, satisfying

$$50\exp(-0.4d) < SG < 360\exp(-0.47d),$$

wherein d(μm) is the thickness of the liquid crystal layer and SG is the scattering gain of the liquid crystal layer.

147. The liquid crystal display device according to Claim 97, satisfying

$$50\exp(-1.6\Delta n \cdot d) < SG < 360\exp(-1.88\Delta n \cdot d),$$

wherein d(μm) is the thickness of the liquid crystal layer, SG is the scattering gain of the liquid crystal layer, and Δn is the birefringence anisotropy of the liquid crystal material

148. The liquid crystal display device according to Claim 97, wherein the scattering gain of the liquid crystal layer is at least 10 and at most 200.

149. The liquid crystal display device according to Claim 97, wherein the scattering gain of the liquid crystal layer in a usage temperature range of the liquid crystal display device is at least 10 and at most 200.

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